Shifting Gears, Shifting Niches: Organizational Inertia and Change in the Evolution of the U.S. Automobile Industry, 1885–1981

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Abstract
We examine how experiential learning affects organizational change and its consequences on firm mortality. We develop hypotheses about the interactions of experiences with a specific type of organizational change on the one hand, and environmental stability, organizational size, and organizational niche width on the other hand. Our findings draw from analysis of the U.S. automobile industry between 1885 and 1981 and support the general prediction that "process" effects of change in the organizational core elevate the hazard of failure. We also find that a dynamic interpretation of organizational environments as comprised of other organizations helps to explicate the interplay between organization and environmental forces that shape the occurrence and outcome of transformation.
(*Inertia*; *Organizational Change*; *Niche*; *Automobile Industry*)

1. Introduction
Ecological theory posits that an organization's ability to change is limited by the structural conditions—both internal and external—in which it is embedded (Hannan and Freeman 1984). The argument runs counter to traditional perceptions about organizations as adaptive to environmental shifts and able to implement change from within (Pennings 1975).[1]

Despite the volubility of early debates, much contemporary research on organizational change aims to reconcile the different perspectives about adaptation (Levinthal 1991, Haveman 1992, Dobrev 1999, Gavetti and Levinthal 2000). A popular approach that has been offered within this vast literature might be called "the content-process modeling framework" (Barnett and Carroll 1995). This framework holds that to understand the differences between adaptation and selection, the (content) effects pertaining to the destination state in an organizational transformation need to be separated from the obstacles and impediments related to undertaking the transformation (process effects). So, although inertial pressures may be triggered during the process of change, adaptation may be successful if they can be overcome and if the destination state to which the organization moves is indeed beneficial.

Within this framework, a rapidly growing series of empirical studies follow Amburgey et al. (1993) and Haveman (1992) in analyzing the consequences of specific types of structural change in complete organizational populations. In general, findings from these studies link inertia to disruptive process effects. They suggest that the detrimental effect of "core" structural change occurs independently of the state (content) effect and lasts for the duration of the transformation.[2]

While these and other studies generally agree with the basic ecological prediction, there is a concern that models of change effects typically underspecify content effects, often relegating them to the level of control variables (Carroll and Hannan 2000). A common content omission lies in the failure to tie in theoretical arguments related to the initial triggers of organizational change (Greve 1999, Barnett and Carroll 1995). This neglect potentially undermines the reported findings regarding process effects—A thorough understanding of process effects can flesh out only when the interplay between the environmental and organizational forces that induce and modify a transformation is consistently accounted for.

Unfortunately, organizational theory about the processes of change is underdeveloped. Analysts typically assume (often implicitly) that organizations are either action oriented or inert, depending on which assumption fits the context and their arguments (Barnett and Carroll 1995). In predicting action, theorists frequently

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envision organizations that are readily capable of making correct assessments of their environments. However, just because researchers can arguably identify attractive market structures in retrospect by no means implies that firms were able to do so contemporaneously (March 1978). Obviously, there is plenty of room here for theoretical development.

In our view, a potentially useful point of development involves considering how environmental constraints and opportunities interact with the internal perception and interpretation of organizational experiences. It is clear that the antecedents of organizational change hinge at least partly on the internal processes by which responses to environmental developments are assessed (Greve 1998, O'Reilly et al. 1993). So, using theoretical ideas about experiential learning to examine simultaneously both rates of organizational change and the consequences of change might provide more insight.

Using the historical U.S. automobile industry as a research setting, we attempt to illustrate the potential value of this approach here. As our focal point, we concentrate on organizational change emanating from change in the niche, defined as market position in technological space. The conceptual utility of the niche is twofold here: First, it allows us to formulate concrete theoretical arguments and use them to develop testable empirical propositions, and second, it facilitates the integration of various theoretical frameworks and ideas from an established and growing stream of research.[3]

In particular, we use a dynamic model of the evolution of organizational niches (Dobrev et al. 2002) to define state effects in the content-process analysis of transformation. Tying "micro" processes within the niche to long-term changes in the broader environment, this model builds on evidence about the relationship between an organization's niche and evolution in the structure of its organizational population over time. Focused on the technological niche, this specification attends to processes of positioning and crowding among firms in the niche space. In the environment, these processes are related to the level of concentration among all firms in the market. Substantively, the model posits that the propitious effects of both niche width and position in the favorable market center depend on the overall consolidation of the industry, reversing themselves in cases of high concentration. Informed by the theory of scale-based selection (Carroll and Swaminathan 2000, Dobrev and Carroll 2003), the model predicts intense scale competition among most automobile producers and predicts that the smallest producers benefit from a highly concentrated market. It also posits that crowding within a firm's specific technological niche elevates mortality, but that when concentration is high, crowding becomes beneficial.

Theoretically, we build on ecological insights about structural inertia (Hannan and Freeman 1984) and experiential learning (Levitt and March 1988). We attempt to explain, first, auto firms' propensity to shift niches and, secondly, their likelihood of surviving such shifts. For both dependent variables, we develop hypotheses concerning how repeated niche changes of a firm interact with three independent variables: market stability, organizational size, and organizational niche width. We test these hypotheses within the cumulative model specification mentioned above, which includes many previously established effects of organizational age, size, and environmental characteristics (Dobrev et al. 2002).

2. Organizational Inertia and Rates of Niche Shifting

Experiential Learning and Frequency Dependence

As noted above, we believe that understanding the outcome of an organizational transformation should begin with an investigation of the ways by which the change came about in the first place. It is widely believed that experience impacts the propensity of an organization to implement change. As it gains experience in undertaking a particular type of change, an organization becomes more likely to attempt a similar transformation in the future (Amburgey et al. 1993). Experience with a certain type of change also tends to constrain future transformations: The organization becomes less likely to experiment with different types of transformation. The extreme case of this constraint is what Levitt and March (1988) call a "competency trap," whereby organizations proceed down known courses of action even when inappropriate. Therefore, not only can change be derailed by inertia, but inertia can emerge as an outcome of change. In other words, learning and inertia both emerge as a function of past experiences (Kim et al. 2003) and experiential learning invariably entails both opportunities and constraints (Sørensen and Stuart 2000; Ingram and Baum 1997a, b).

Of course, answers to questions of why organizations change also require consideration of both environmental and organizational characteristics, as well as the interplay between them and experience. The interaction is particularly important because it reveals the internal mechanisms through which organizations interpret and react to their external context. Following Levitt and March (1988), we attend to three aspects of experiential learning in organizations: (1) interpretation of experience, (2) complexity of experience, and (3) ambiguity of success. From this analysis, we develop hypotheses predicting that organizational experiences interact with environmental structure (shifts in the market center) and structural properties of the organizational design (organizational size and niche width).

Environmental Stability and the Interpretation of Experience

Because an organization's environment consists mostly of other organizations, its propensity to change is modified by its relationship with other organizations. In support of this conjecture, Miner et al. (1990) reported that Finnish newspapers affiliated with external political parties have a higher propensity to change, while Haveman (1993b) found that when large and profitable savings and loan associations decide to diversify, smaller organizations are likely to follow suit. Similarly, Greve (1995) discovered that the decision to abandon strategic position is largely driven by social contagion. Because firms constantly strive to outmaneuver or respond to the actions of their competitors, we conceive of the organizational environment in terms of the structure of the market center, defined by the technological niches of the four largest firms in the industry. We do not engage in speculation of whether shifts in the market center reflect constraints or opportunities for most firms, but contend that these shifts likely require all contemporaneous organizations to realign their positions with the new configuration. The empirical expectation is that shifts in the market center will trigger change in market position at the organization level and that market stability will impede such change. More important, we are interested in the combined effect of exogenous (market change) and endogenous (experiential learning) characteristics on the organizational propensity to implement change in market position.

A major issue of organizational learning concerns how to interpret experience (Levitt and March 1988). In a market, the volatility of the setting likely matters, both in understanding what happened and in applying this knowledge to possible future action. We suspect that organizational intuition to engage recurrently in a behavior that has produced positive results in the past may interfere with its capacity to interpret market signals objectively. If this is correct, then the acquired propensity to change because of prior success may override the visibly better alternative to not change when the market remains stable. When environments demand realignment and repeating an experimented change is an adequate strategy, experienced organizations are in a superior position because they are more likely to initiate that same or similar change. However, when environments are stable, these organizations are at a disadvantage. This is because relative to firms without prior change experience, they are more likely to follow the "wisdom" of their experience, are more prone to misinterpret or underestimate exogenous conditions, and are thus more likely to change. If changes in niche position are path dependent over time, then we expect to see experienced organizations initiating change even when this leads to a misalignment with stable environments. Our argument posits that although market stability likely decreases the likelihood of change for all organizations, experienced firms will be more likely to make change under stable conditions than will inexperienced ones.

Because our argument refers to the relative difference in propensity to change between firms with and without prior change experience, we use the term "relative momentum of change" to describe this difference in the likelihood of undergoing internal transformation between the two sets of organizations. It should be distinguished from the familiar interpretation of "momentum of change" which researchers have used to describe the absolute effect of prior change on subsequent reorganization (Amburgey et al. 1993, Amburgey and Miner 1992, Kelly and Amburgey 1991).

HYPOTHESIS 1 (H1). *The negative effect of market stability on change will be weaker when relative momentum is high.*[4]

Organizational Size and the Complexity of Experience

Features of an organization's design also impact its rate of change (Zajac and Shortell 1989). Research on rates of change in organizational populations shows that the propensity to initiate transformation generally declines with size (Haveman 1993a). Substantively, the explanation for the negative relationship between size and transformation centers on arguments about the complex and bureaucratic nature of large organizations. One interpretation sees complex and bureaucratic organizations as slow and clumsy, facing greater demands for balancing incentives and coordination among a growing number of internal constituents. Efforts to meet such demands invariably reshuffle organizational priorities and the ways in which resources are distributed. Another interpretation relates to the changing role of innovation and experimentation in complex large companies. As the organization expands, these processes become internalized and embedded in the developing organizational structures; innovation becomes routinized.

Large organizations also likely face difficulty in interpreting their experiences. As the number of subunits and persons within an organization increases, the number of possible relations among them increases geometrically. The sheer amount of information required to store all behavior of a large organization strains cognitive limits. Also, both bureaucracy and institutionalization make it difficult to understand what happened and why because some (often not easily identifiable) actions are routine responses and others are not. Such complexity of experience likely makes it harder to act in the future because it is unclear what outcome might be expected and there are ample rationales available to those who would resist the action. So, integrating ideas about experiential learning (which empirically implies relative momentum of change) and features of the design related to the complexity of experience, we argue:

HYPOTHESIS 2 (H2). *The relative momentum of change will decrease as the organizational size increases.*

Organizational Niche Width and the Ambiguity of Success

Organizational growth also often breeds expansion in the organizational niche, thus constraining exploration to occur mostly within the scope of the firm. When the range of resources that constitute organizational inputs is high, an organization is less pressed to explore beyond its boundaries. The variation of outcomes needed to support experimentation and learning can be produced within its niche. Therefore, even though high variance in resource utilization facilitates exploration, organizational learning is likely to occur locally (in terms of market position), within the domain of the broad-niche firm.

Organizations with broad niche width—generalists in ecological theory—also face problems of interpreting their experiences, which are likely to increase inertia. Specifically, a generalist organization participating in a broad array of market segments encounters a problem of ambiguity regarding success and failure (Levitt and March 1988). That is, the fate of the combined entity can be plausibly attributed to a variety of activities or segments by internal actors, whether they are truly related or not. As with complexity, the resulting plethora of rationales likely inhibits future action:

HYPOTHESIS 3 (H3). *The relative momentum of change will decrease as the organizational niche expands.*

3. Structural Inertia and Organizational Survival

In analyzing the relationship between organizational change and survival chances, we build on arguments about the core-periphery distinction to develop hypotheses about how organizational size and organizational niche width will interact with a change in niche width in affecting mortality.

Core vs. Peripheral Organizational Change

Selection and adaptation models of organizational change are often considered in terms of the differential consequences brought about by changes in the organizational core versus the periphery. Because reliability and accountability emerge from the reproducibility of core structures, inertial forces (along with the selection advantage derived from reliability and accountability) emanate from core features of organizations. Many demographic studies of organizations find that core structural change is a precarious process; it leads to an elevated probability of organizational failure, even if the desired end state is on target. Changes affecting the noncore or periphery structure do not produce the same outcome; they might even lead to a lower risk of mortality.

Hannan and Freeman's (1984) original definition of the organizational core gives a hierarchical list of four core features, including an organization's mission, its authority structure, its technology, and its marketing strategy. Empirical applications of the inertia theory using this definition of organizational core are not unequivocal in their interpretations of core structures, though most do find support for the prediction that core change elevates mortality (see Carroll and Hannan 2000 for review) and at least temporarily adversely affects performance (Audia et al. 2000, Greve 1999, Miller and Chen 1994).

Recent elaboration of the inertia story claims that the deleterious process effects result from the length of time necessary to replace structural and cultural codes governing blueprints for conducting transactions (Hannan et al. 2001). The time to complete such replacements depends on the centrality and connectedness of these units in the overall organizational structure (Barnett and Freeman 2001). By this imagery, the degree of internal and external misalignment that occurs during the process of change depends on the *location* of change within the organization—specifically, on the centrality of units subjected to transformation attempts. Because intended change in centrally located units triggers unintended change in units to which they are connected, the duration of transformation also increases. So, consequently, do the expected negative effects of process change.

Most studies of inertia resolve the location-of-change issue by applying the core-periphery framework

(Hannan and Freeman 1984) for analyzing structural change in organizations. A typical research design of this sort usually begins by defining what organizational features constitute the core, and then formulates predictions about transformations in those features. So the "*core*ness" of any structural element is based on analysts' assumptions about a specific class of organizations. For example, Singh et al. (1986) regard CEO succession as a peripheral change, while editor-in-chief replacement is defined as an indicator of core change by Dobrev (1999). The problem pertains partly to excess generality in conceptualizing the core-periphery distinction: What constitutes a core organizational feature in one organization can be a peripheral structure in another. These discrepancies appear not only with comparisons of organizations with different forms and identities, but also to firms within the same population.

A more intuitive way of conceptualizing core features and change in the organizational core stems from the insight that the adverse impact of transformation arises from its unintended effects. Because the unanticipated consequences of organizational change are a direct function of the extensiveness of change, core transformation is defined in terms of the additional subsequent unplanned changes that need to be implemented as a result of the initial change attempt. It is such cascades of change throughout the organization that largely account for the indirect and opportunity costs associated with the transition between two states (Hannan et al. 2001).

Organizational Size and the Complexity of Core Changes

We define change in market position as shifts in the center of a technological niche (initiated by the organization) and propose that the extensiveness of change will depend on the size of the organization. We construe organizational size as an important source of structural complexity and variability that reorders otherwise similar organizations on the core-periphery dimension. We trace this supposition to research that links the structural complexity of an organization with inertia (Hannan and Freeman 1989, Barnett and Carroll 1995), suggesting that complex organizations are inherently less capable of initiating and surviving fundamental change. Hannan and Freeman argue that, "the level of structural inertia increases with size for each form of organization" (1989, p. 82). A direct causal relationship between scale, complexity, and inertia implies that large organizations with dense and saturated structures will be hard, and slow, to change. So, it follows that if "complexity increases the risk of mortality due to reorganization" (Hannan and Freeman 1989, p. 89), so too does scale of operations. For these reasons, we surmise that large size implies extensive changes in structures and routines throughout the rest of the production process and the organization. The empirical implication is an interaction effect between niche center change and organizational size:

HYPOTHESIS 4A (H4A). *The deleterious effect of niche center change on the mortality rate increases with the size of organization.*

The argument made above runs counter to predictions that large organizations have a greater margin of error that allows them to buffer the negative repercussions of core transformation (Levinthal 1991). This advantage attributable to large size emanates from the superior resources that large organizations command. Indeed, researchers who criticize the theory of structural inertia point out that powerful organizations in established, economically central industries possess the capacity to not only withstand internal change, but to impact the course of industry development. In this way, exogenous changes in the environment that often instigate attempts at internal transformation for most organizations effectively become endogenous to very large organizations. We think that this argument is at least partly relevant for the U.S. automobile industry, which for most of its postwar history has been dominated by a few leading producers. We also conjecture, however, that this logic applies only to very large (as opposed to all large) firms, while inertia considerations ought to prevail in predictions of survival chances for the remaining subset of scale competitors, subjected to core transformation. In other words, across very high counts in the size distribution, the effect of superior access to resources overrides the positive effect of process change in the core on organizational failure (Carroll and Teo 1996).

HYPOTHESIS 4B (H4B). *The effect of size on the mortality hazards of organizations experiencing a niche center change is nonmonotonic, reversing from positive to negative across very high levels of organizational size.*

Organizational Niche Width and Core Change

Finally, we address the issue of variance in responses to inertia. We ask the question whether all organizations experiencing internal and external misalignment are equally liable to inertial pressures, and to answer this question, we investigate the organizational properties that we suspect might—at least partially—help offset the detrimental forces of environmental selection.

Are all inert firms equally likely to fail? This becomes a salient question once we agree on the evidence showing that inert firms are more likely to fail than noninert ones as a result of undergoing internal restructuring. A general answer is that some organizational characteristics might serve as buffers against inertial forces. But which characteristics? As organizations grow in age and size, they become senile, rigidly bureaucratized, and burdened by obsolete blueprints. Yet at the same time past experiences and exposure to different contexts also provide learning opportunities for cumulating and interpreting knowledge—the so-called tacit, organization-specific capital, cognitively stored in the collective memory of the organization. Organizations that actively promote learning and exploration might also have a greater chance of weathering selection pressures.

Theories of organizational learning posit that a principal mechanism by which firms learn from their experiences involves continually investing resources to support organizational search for new and better routines and solutions (March 1991, Levitt and March 1988). The success of this strategy depends on the extent to which an organization can surmount pressures for efficiency and slack-cutting and commit to building and sustaining variation of outcomes to be considered as viable alternatives to existing routines and practices. In sorting out differences among firms in their ability to learn, we think that organizational niches ought to matter (Stuart and Podolny 1996). Specifically, the variation necessary for learning will more likely be produced and maintained by broad-niche organizations (generalists) that operate across multiple environmental states and encompass large operational domains. Additionally, broad-niche firms possess experience with transferring resources between operational units, experience that may be drawn upon in case the organization undergoes a market repositioning and needs to move resources from the origin to the destination state of the transition.

Indeed, the purported advantage of generalist firms lies in their hedging strategy (Freeman and Hannan 1983)—They spread their bets across several alternatives with uneven pay-off opportunities. Specialists, by contrast, bet their success on exploiting a single narrow niche. This focused strategy inevitably results in a trade-off between static efficiency and dynamic adaptability because it deprives the organization of the opportunity to develop a broad set of competencies that can be applied to multiple market domains, and to gain experience in transferring capabilities and resources across these domains. Broad-niche firms also benefit from internal variation—selection-based learning (Weick 1969). Therefore, the generalist advantage manifested in a greater flexibility and higher capacity for adaptation serves as a buffer against the negative impact of process change. It follows that the deleterious process effect of change ought to vary by niche width.

Hypothesis 5 (H5). *The mortality hazard of an organization that changes its niche center is a decreasing function of organizational niche width.*

4. Data and Methods

We report here analyses of data on all American automobile producers ever known to operate from 1885 to 1981. These data derive from a larger collection effort that coded histories of automobile manufacturers worldwide, using reports of automobile historians and collectors (Hannan et al. 1995). The most comprehensive information comes from a multivolume encyclopedic source book that provides thorough authoritative coverage: *The Standard Catalogue of American Cars* (Flamang 1989, Kimes and Clark 1989, Gunnell et al. 1987, Kowalke et al. 1997). Supplementary information for recent periods can also be found in Kutner (1974) and *Automotive News* (1993). The collection effort revealed an abundance of firms. We found data on 2,197 American automakers, many of whom were small, short-lived, and obscure firms that introduced highly novel automobile designs and production schemes.

Mortality Events: Outcome State Space

Organizational life histories end in a variety of ways. For American automobile firms, the most important events associated with the ending of an observed life history involve one of the following: (1) disbanding of the firm, (2) exit to another industry, or (3) merger or acquisition by another firm. The meaning of disbanding has no ambiguity: The firm failed as a collective actor. In automobile manufacturing, exit to another industry also suggests a lack of success. The other ending events are harder to interpret. Because of the ambiguous meaning of mergers and acquisitions, we base our analysis on disbanding and exit to another industry.

The sources do not tell exactly what happened to most firms when they dropped from the set of producers; this is invariably the case when spells of automobile production were short and when production scale was tiny. Our reading of the historical materials for the U.S. industry indicates clearly to us that most exits of unknown type were either disbandings or exits to other industries. So, we treated these two events alike: the outcome event of interest in this analysis is *disbanding/exit to another industry*, defined to include events of unknown type. Firms known to have ended by other events (merger, acquisition, etc.) were treated as (noninformatively) censored on the right at the times of these events, per standard practice in event-history analysis.

Variables

We follow convention in modeling a firm's *tenure* (u) in a particular organizational population rather than its organizational age. Some firms' records indicated that they conducted other activities prior to entering the automobile market. Because these *de alio* firms likely entered with greater resource bases than *de novo* firms, we included a dummy variable to indicate *prior existence* (prior existence). Carroll et al. (1996) showed that this variable is associated initially with lower mortality risks.

We specify the effects of organizational *density* (N) in nonmonotonic fashion, consistent with established theory and findings in organization ecology (Carroll and Hannan 2000). This specification includes a linear and second-order term (N^2) of annual counts of the number of producer organizations. Following Hannan (1997), we interact the effects of the contemporaneous density variables with a set of variables measuring the *age of the population* (ind. age). This specification allows the effects of density to vary as a function of population age. We also include a fixed covariate for each firm measuring *density at the time of its industry entry* (density at entry).

Organizational Size

We measured organizational *size* as scale of operations, specifically the firm's annual production of automobiles (ln(size)). Previous analyses (Hannan et al. 1998a, b) of automobile industries also measured *relative size* of a firm as the ratio of each firm's size to the size of the largest firm in the national population at the time (relative size). For our measure of *market concentration* we rely on the frequently used concentration ratio measure, defined as the ratio of the annual production of the four largest firms to the total industry output for that year (C4).

A promising way to model the competitive pressure in scale-intensive industries comes through examining the size structure of the competitive environment faced by each scale competitor at any point in time (Carroll and Swaminathan 2000). For this purpose, we use the exact same scale competition measure developed by Dobrev and Carroll (2003), and measure the aggregate distance of all larger firms from the focal firm among competitors whose size exceeds the annual scale production threshold of 50, specified by Dobrev and Carroll (2003). According to this measure, the greater the number of larger competitors a firm faces, the greater the competitive pressure it confronts, all other things equal. The contribution of each larger firm to its competitive pressure depends on the firms' exact locations. When the focal firm is small, then a unit size difference creates more pressure than when it is large. Put another way, the same difference in scale between two firms generates more competitive pressure for the smaller firm when its absolute size is small than when its absolute size is large. In the analysis below, we also use a *very small size* dummy variable for size less than or equal to an annual production of 50 cars (size ≤ 50) to model the rate change and survival dynamic of nonscale competitors.[5]

Technological *niche width* (NW) is defined as the range of engine capacity in horsepower across all models produced by each firm in any given year. *Niche overlap* density (NO) refers to the count of firms whose niches overlap with the niche of the focal firm.[6]

The *market center* covers the range of the niches of the four largest firms in the industry each year. Market-center change can occur in one of two ways: First, the niche of at least one of the four largest producers changes between two years in a way that shifts the boundaries of the market center to reposition its midpoint; note, however, that it is possible for as many as all four leading firms to change their niche profiles without impacting the existing boundaries of the market center. This is important because it makes it hard for other firms in the industry to distinguish the occurrence of change in the market position of an industry leader from actual changes in the market structure. The second way in which the market center can change is if there is turnover in the top four industry leaders such that a newcomer's entry into the top four influences the boundaries of the market center. Again, even a complete turnover of the four largest firms can occur without any shifts in the market center. *Market-center stability* is a dummy variable that equals unity if the midpoint of the technological niches of the four largest firms in the market does not shift between two consecutive years.

Distance away from the market center is measured as the difference between the midpoint of the focal firm's niche[7] and the midpoint of the market center. We estimate the effects of the distances of firms both "*above*" *the market center* (position: DAMC), meaning a niche width that contains a larger engine capacity than the center, and "*below*" *the market center* (position: DBMC). We measure *change in relative position* as the difference in the distance from the market center at which the firm's niche midpoint stands between two consecutive years, and absolute position change (*niche-center change*) refers to the difference in each firm's niche midpoint between two consecutive years. We focus our analyses on absolute position change because this type of change, by definition, must be initiated by the focal firm. By contrast, relative position change is used as a control because this type of change can be registered even if the firm's niche remains static, but a shift in the market center occurs between two consecutive years. *Cumulative niche-center change* (CNCC) sums the number of prior changes in a firm's niche center and *time since last change* is a clock variable that counts the years elapsed since the last niche-center shift.

Although using a single dimension to define organizational niches has its limitations, a technology-based definition allows us to draw meaningful comparisons among firms that have existed in remote historical periods, and thus makes it possible to analyze the industry in its entirety. Moreover, the technology dimension is a good indicator of the firm's overall strategy and market position (Stuart and Podolny 1996). Similarly, when used to define internal transformation, technological change reveals the correspondence between such change and shifts in market position, as well as the ensuing organizational difficulties that they entail. Many historical and anecdotal accounts of the industry accord with our interpretation:

> In 1938 the Ford Motor Car Co. tried to reach a new group of customers by introducing a car that was smaller than their V8 in size and power. After several years of development they produced a car (dubbed 92A) that was narrower, shorter, and 600 pounds lighter than the regular Ford. However, the small motor cost only $3 less to manufacture and the entire car could be built for only $36 less than the big car.... [T]he project was abandoned, signifying that the company would not expand the range of its models downward. (Nevins and Hill 1963, p. 118)

Analogous examples abound throughout the history of the industry and reinforce the validity of our measures.

We also control for socioeconomic environmental conditions. The estimates we report below are from specifications that include effects of *economic depression* (depression year dummies), the level of the *gross domestic product* (GDP) adjusted for inflation (taken from Maddison 1991), and dummy period effects representing *industry regimes* (mass production, product differentiation, JIT/TQC) as defined by Womack et al. (1990). We excluded the years of the Second World War from the analysis because the production of motor vehicles for private use in the United States was minimized for the duration of the war. This specification of socioeconomic environmental factors parallels those of Hannan et al. (1998a, b) and allows for precise model comparisons.

Model Specification and Estimation

We represented variation in organizational tenure (u) as a stochastic piecewise-exponential function where the breakpoints for the pieces are denoted as $0 \leq \tau_1 \leq \tau_2 \leq \cdots \leq \tau_P$. Assuming that $\tau_{P+1} = \infty$, there are P periods: $I_p = \{u \mid \tau_p \leq u \leq \tau_{p+1}\},\ p = 1, \ldots, P$. After examining life tables and exploring estimates of a variety of choices of the breakpoints, we decided to break the duration scale in the failure-rate analysis (in years) at: 0.5, 1.0, 3.0, 7.0. Distribution of events in the rate of change in the niche analysis indicated that a more appropriate set of breakpoints in the tenure would be at: 1.0, 3.0, 7.0, 15.0.

We specify that both the disbanding/exit and the niche change rates (r_i) are a function of tenure in the industry (u); industry age (t); a vector of variables ($\mathbf{s}'_{iu}$) pertaining to size (absolute and relative size, aggregate distance from larger competitors, and dummy for very small size); a vector of other measured covariates ($\mathbf{x}'_{it}$) including GNP, depression year, and density at founding; and a function of niche width, market position, niche overlap density, and their interactions with concentration, denoted by $\psi(\cdot)$. The functions for assessing the arguments made in the hypotheses relate to the effects of various measures of change in organizational position (ΔPOS) and in the market center (ΔMC), denoted by $\omega(\cdot)$. The failure-rate models also include a function for assessing the effects of contemporaneous density and density squared, as well as the interactions of these density effects and industry age, denoted by $\varphi(\cdot)$. The general class of models we estimate has the form:

$$
\begin{aligned}
r_i(u, t) = {} & \exp(m_p) \exp(\mathbf{s}'_{iu}\alpha_p + \mathbf{x}'_{it}\pi)\, \varphi(N_t, t) \\
& \cdot g\psi(\mathrm{NW}_{iu}, \mathrm{NO}_{iu}, \mathrm{POS}_{iu}, \mathrm{C4}_t) \\
& \cdot g\omega(\Delta\mathrm{POS}, \Delta\mathrm{MC}), \quad u \in I_p.
\end{aligned}
$$

Here m_p denotes a set of tenure-specific effects; the log-linear link imposes the constraint that the baseline hazards be nonnegative. The (tenure) period subscript on the vector of size coefficients indicates that we allow these effects to vary by tenure in the failure-rate models. We estimated models using the method of maximum likelihood, as implemented in TDA 5.7 (Rohwer 1994, Blossfeld and Rohwer 1995).

Descriptive statistics for the variables in the event-history file used in model estimation are presented in Table 1a and their correlation matrix appears in Table 1b. As per convention with time-varying covariates, this is a "split-spell" file with spells artificially censored each year and the values of the covariates updated.

Modeling Strategy: Cumulative Specification

We build cumulatively on previous findings to estimate a "larger" model of organizational evolution. These findings include specifications of tenure dependence, size dependence, density dependence (Carroll et al. 1996; Hannan et al. 1998a, b), scale competition (Dobrev and Carroll 2003), and niche evolution (Dobrev et al. 2002). Given the complexity of the ideas in the hypotheses and the models, we do not dwell on estimates of each of these effects, but simply report them. Note, however, that their inclusion is central to our claims of building a unified model.

To model effects of changes in niche width and position, we experimented with both dichotomous and continuous measures. In both rate of failure and rate of change analyses the coefficients estimated using the continuous and dummy measures are remarkably similar, but the models with the dummy specification provide a significantly better fit for the data. For this reason, we report the results from these specifications.

5. Findings

We first report analysis of niche shifts, designed to test Hypotheses 1–3. We then turn to the models of the effects of niche change on organizational mortality.

Rate of Position Change

The results of the rate of change analysis are presented in Table 2. The baseline Model 2a includes the positive and significant effect of cumulative change, which agrees with the frequency dependence argument. While experiential learning promotes the occurrence of change, market stability deters it: The main effect of the environmental variable for market-center stability is negative and significant, as expected.

In the next model (Model 2b in Table 2), we add the interaction effects that test Hypotheses 1–3. In accord with H1, the negative effect of market-center stability is weaker for firms with increasing cumulative change

Table 1a Descriptive Statistics for the Variables in Life-History Spell File

#	Label	Min	Max	Mean	Std. Dev.
V1	Mass Production	0.00	1.00	0.90	0.30
V2	Production Differentiation	0.00	1.00	0.14	0.35
V3	JIT/TQC	0.00	1.00	0.08	0.27
V4	Depression Year	0.00	1.00	0.17	0.38
V5	Density	1.00	345.00	204.90	109.55
V6	Density at Entry	1.00	345.00	224.87	106.44
V7	Ln(Size + 0.1)	−2.30	15.48	3.12	3.48
V8	Relative Size ($\times 10^{-3}$)	0.00	5,284.50	35.55	284.97
V9	Size $\leq$ 50 (Dummy)	0.00	1.00	0.68	0.47
V10	Prior Existence (Dummy)	0.00	1.00	0.57	0.50
V11	GDP	42.40	977.10	200.75	221.07
V12	Niche Width (NW)	0.01	552.01	12.93	32.09
V13	Niche Overlap (NO)	0.00	362.00	86.12	82.75
V14	Position: Distance Above Market Center (DAMC)	0.00	206.50	3.95	9.89
V15	Position: Distance Below Market Center (DBMC)	0.00	364.25	16.95	33.02
V16	Change in Relative Position	0.00	275.02	5.18	11.79
V17	Niche-Center Change (Dummy)	0.00	1.00	0.52	0.50
V18	Cumulative Niche-Center Change (CNCC)	0.00	53.00	3.83	6.57
V19	Time Since Last Change	0.00	9.00	0.17	0.66
V20	Market-Center Stability (Dummy)	0.00	1.00	0.45	0.50
V21	Industry Concentration (C4)	0.31	1.00	0.65	0.21
V22	Scale Competition $\times$ Size > 50	0.00	59.92	1.06	3.43

Table 1b Correlation Coefficients for Variables in the Life-History Spell File

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16	V17	V18	V19	V20	V21	V22
V1	1																					
V2	0.13	1																				
V3	0.09	0.72	1																			
V4	0.05	−0.18	−0.13	1																		
V5	0.28	−0.60	−0.41	−0.07	1																	
V6	0.24	−0.60	−0.45	0.04	0.70	1																
V7	0.21	0.14	0.09	0.05	−0.24	0.03	1															
V8	0.04	0.20	0.12	−0.02	−0.17	0.08	0.39	1														
V9	−0.17	0.01	0.04	−0.06	0.09	−0.09	−0.86	−0.18	1													
V10	−0.01	−0.28	−0.25	0.03	0.18	0.21	0.10	−0.05	−0.16	1												
V11	0.19	0.90	0.90	−0.15	−0.57	−0.55	0.18	0.18	−0.01	−0.29	1											
V12	0.08	0.49	0.19	−0.06	−0.34	−0.14	0.37	0.64	−0.19	−0.08	0.34	1										
V13	−0.13	−0.33	−0.25	−0.04	0.50	0.35	−0.22	−0.08	0.12	0.10	−0.37	−0.06	1									
V14	−0.05	−0.03	−0.02	0.08	−0.02	−0.01	0.02	−0.01	−0.04	0.02	−0.04	0.03	−0.07	1								
V15	0.14	0.65	0.41	−0.06	−0.51	−0.53	0.07	−0.01	−0.01	−0.19	0.63	0.20	−0.38	−0.20	1							
V16	0.11	0.34	0.27	−0.02	−0.25	−0.20	0.19	0.11	−0.13	−0.05	0.31	0.27	−0.17	0.06	0.26	1						
V17	0.06	0.16	0.15	−0.02	−0.12	−0.14	0.19	0.06	−0.17	−0.00	0.18	0.16	0.13	−0.05	0.05	0.28	1					
V18	0.14	0.23	0.16	0.03	−0.30	0.01	0.59	0.49	−0.45	0.05	0.25	0.52	−0.16	0.03	0.04	0.25	0.37	1				
V19	0.07	0.04	0.05	0.01	0.01	0.07	0.19	0.03	0.20	0.09	0.03	0.01	0.11	0.07	0.03	0.00	0.27	0.10	1			
V20	−0.07	0.04	0.01	0.06	−0.18	−0.10	0.08	0.02	−0.06	0.00	0.05	0.00	−0.08	0.02	0.07	−0.14	0.02	0.06	0.02	1		
V21	0.02	0.65	0.50	−0.06	−0.77	−0.56	0.34	0.17	−0.18	−0.18	0.68	0.34	−0.59	−0.01	0.56	0.30	0.14	0.35	0.07	0.00	1	
V22	0.09	−0.09	−0.06	0.03	0.07	0.08	0.19	−0.03	−0.45	0.05	−0.06	−0.05	−0.04	0.08	−0.06	0.00	0.02	0.04	0.11	0.01	0.01	1

Table 2 Estimated Effects of Prior Position Change on the Rate of Position Change of U.S. Automobile Manufacturers, 1885–1981

	2a	2b	Hypothesis Tested
Technological Niche Width and Position			
Niche Width (NW)	−0.01 (−1.07)	−0.01 (−1.28)	
Position:			
Distance Above Market Center (DAMC)	0.004 (0.47)	0.004 (0.47)	
Distance Below Market Center (DBMC)	−0.06 (−7.12)	−0.06 (−6.54)	
Change in Relative Position	0.01 (4.92)	0.01 (5.18)	
Evolutionary Processes:			
C4 × NW	0.01 (1.03)	0.01 (1.53)	
C4 × Position: DAMC	−0.02 (−1.96)	−0.02 (−1.86)	
C4 × Position: DBMC	0.06 (6.92)	0.05 (6.34)	
C4 × NW × Size ≤ 50	−0.002 (−1.59)	−0.01 (−2.79)	
Overlap Density			
Niche Overlap (NO)	0.01 (5.28)	0.01 (5.34)	
Evolutionary Processes:			
C4 × NO	−0.01 (−4.33)	−0.01 (−4.43)	
C4 × NO × Size ≤ 50	0.004 (4.41)	0.004 (4.59)	
Cumulative Absolute Position Change			
Cumulative Niche-Center Change (CNCC)	0.02 (5.72)	0.04 (5.32)	
Market-Center Stability	−0.72 (−18.2)	−0.88 (−20.5)	
Evolutionary Processes:			
CNCC × Market-Center Stability		0.046 (10.65)	H1
CNCC × Ln(Size)		−0.002 (−2.65)	H2
CNCC × NW		−0.0001 (−2.08)	H3
Number of Spells/Events	8,892/4,653	8,892/4,653	
Number of Parameters	30	33	
LR Test		108.6 (vs. b)	
Log-Likelihood	−5,817.2	−5,762.9	

Note. T-statistics are in parentheses. *u* denotes tenure in the industry. The model also includes the following covariates: Tenure in industry, prior existence, period effects, depression years, GDP, Ln(Size), size ≤ 50, relative size, industry concentration, scale competition measure, and an interaction of industry concentration and size ≤ 50. See Appendix A for the estimated coefficients associated with these variables.

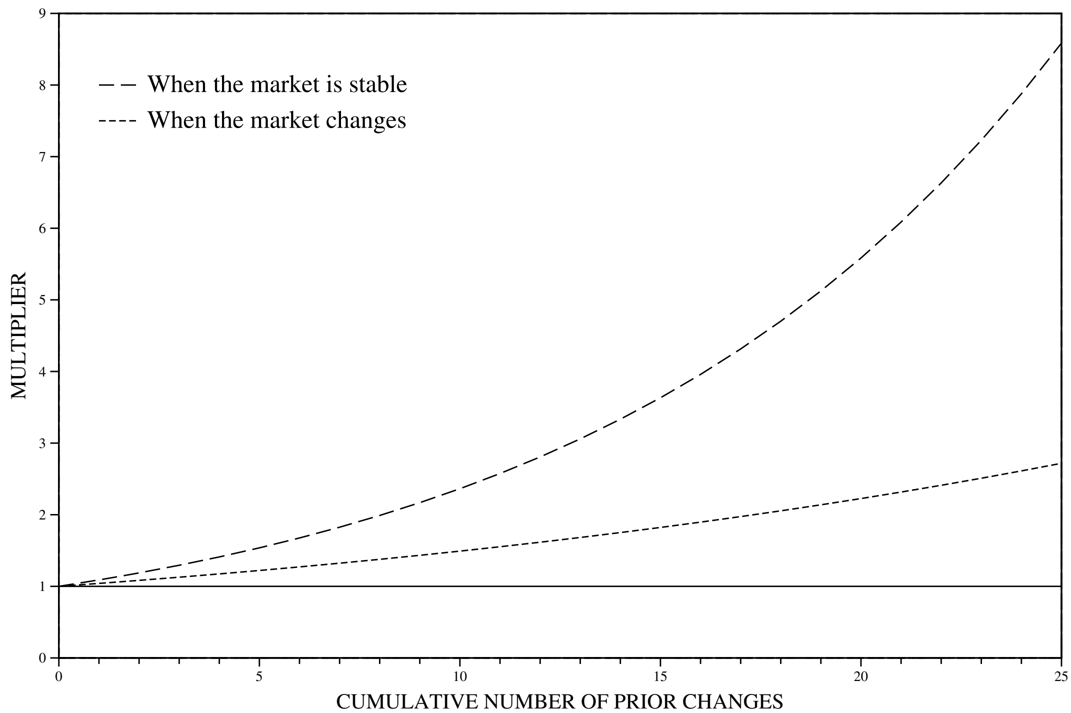
experience. The result suggests an interesting dynamic that we plot in Figure 1: The organizational propensity to change increases with number of prior changes. According to the estimate, a firm with 17 prior change experiences becomes about twice as likely as a firm that had not changed before to undergo niche-center change again ($\exp(0.04 \cdot (17)) = 1.97$). Interestingly, this difference becomes amplified during periods when the market center is stable. According to our estimates, the firm with 17 change experiences becomes 4.31 times more likely to change by misinterpreting environmental signals than a firm without any change experience ($\exp(0.04 \cdot (17) + 0.046 \cdot (17)) = 4.31$). Therefore, even though during market stability all firms are significantly less likely to initiate change, the disparity in the propensity to initiate change between firms with and without prior change experience widens substantially (about 2.2 times in the above example).[8]

Finally, internal growth and expansion appear to slow organizations down. The results lend support to Hypotheses 2 and 3: We estimate significant negative effects on the rate of change for the interaction terms of cumulative change with size and with niche width. Interpreting the coefficients, they reveal that the twice-as-likely-to-change firm with 17 prior change experiences becomes only one and a half times more likely to change if its scale of operation is as high as 2,600. The same decrease in that firm's propensity to change also results from a niche width of 159.

Rate of Disbanding/Exit

Results from the failure-rate analysis are presented in Table 3.[9] The baseline Model 3a contains main

Figure 1 Cumulative Prior Change Effects on the Rate of Change of U.S. Automobile Producers, 1885–1981



effects for market-center stability, niche-center change, and cumulative prior niche-center changes; of these only the latter is significant, suggesting that experience with change increases survival chances upon subsequent change. In the next model (Model 3b) we add the interaction effects implied by Hypotheses H4a, H4b, and H5. To test Hypotheses H4a andH4b, we interacted niche-center change with the log of size and its square, expecting the effect of the former to be positive, and that of the latter to be negative. The estimates agree with our predictions. To help interpret these effects across the observed size range in the population, they are plotted in Figure 2. As the curves indicate, the multiplier of position change on the hazard of failure across the size distribution is nonmonotonic and has an inverted U-shape. It is positive for all firms with the exception of the outliers sitting at both ends of the size distribution: Niche-center change increases mortality for all firms who produce at least six and up to (roughly) one million cars per year. The positive change effect is the strongest for a firm with size 2,600, at which point the hazard is slightly more than 1.7 times as high as that of a firm whose size equals 1.

The estimates also suggest that the positive change effect on the hazard declines with niche width, as predicted by Hypothesis 5. The interaction effect of position change with niche width is negative and significant. The effect implies that learning by exploration can indeed contain the inauspicious process effect of change that impinges on the organizational core. For example, a firm with a size of 2,600 that had implemented position change (and thus increased its hazard by 1.71) must have a niche width of at least 67 in order to counter inertial forces $[\exp(-0.008 \cdot (67)) = 0.59]$.

Effects of Other Covariates

As we discussed above, our model for the exit/disbanding-rate analysis builds on the exact specification estimated by Dobrev et al. (2002). Though we find it unnecessary to review in detail these estimates again here (found in Appendix B), we note the value of empirical cumulativity in building a general evolutionary model of the U.S. auto industry.

We also think that our baseline model in the rate of change analysis, reported in Appendix A, possibly deserves attention, as it contributes to Dobrev et al.'s (2002) model of the evolution of organizational niches. Specifically, we find that as the industry consolidates, the effects of scale, scope, position, and crowding change, not only in the way that they affect survival, but also

Table 3 Estimated Effects of Position Change Variables on the Disbanding/Exit Hazard of U.S. Automobile Manufacturers, 1885–1981

	3a	3b	Hypothesis Tested
Technological Niche Width and Position			
Niche Width (NW)	−0.04 (−4.07)	−0.05 (−4.35)	
Position:			
Distance Above Market Center (DAMC)	0.01 (0.89)	0.01 (1.14)	
Distance Below Market Center (DBMC)	0.04 (3.94)	0.04 (4.29)	
Change in Relative Position	0.0002 (0.05)	0.001 (0.31)	
Evolutionary Processes:			
C4 × NW	0.06 (4.43)	0.06 (4.97)	
C4 × Position: DAMC	−0.01 (−0.69)	−0.01 (−0.91)	
C4 × Position: DBMC	−0.04 (−3.56)	−0.04 (−3.94)	
C4 × NW × Size ≤ 50	−0.01 (−1.31)	−0.01 (−1.42)	
Overlap Density			
Niche Overlap (NO)	0.003 (2.10)	0.004 (2.55)	
Evolutionary Processes:			
C4 × NO	−0.005 (−1.40)	−0.01 (−1.98)	
C4 × NO × Size ≤ 50	0.005 (1.91)	0.01 (2.48)	
Absolute Position Change			
Niche-Center Change (NCC)	−0.13 (−1.71)	−0.33 (−3.56)	
Cumulative Niche-Center Change (CNCC)	−0.04 (−2.91)	−0.03 (−2.44)	
Time Since Last Change	−0.02 (−0.43)	0.03 (0.59)	
Market-Center Stability	−0.03 (−0.47)	−0.05 (−0.75)	
Evolutionary Processes:			
NCC × Ln(Size)		0.22 (3.98)	H4a
NCC × Ln(Size)^2 (× 10^{-1})		−0.14 (−1.99)	H4b
NCC × NW		−0.01 (−2.82)	H5
Number of Spells/Events	8,892/2,051	8,892/2,051	
Number of Parameters	41	44	
LR Test		33.4 (vs. 3a)	
Log-Likelihood	−3,635.5	−3,618.8	

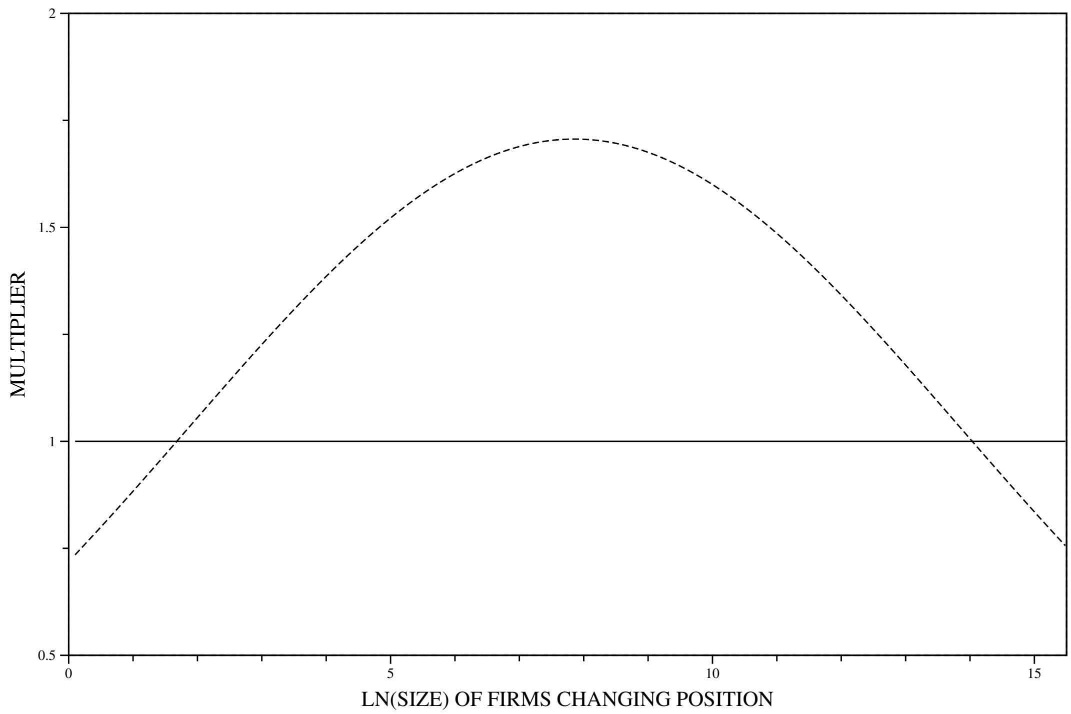
Note. T-statistics are in parentheses. u denotes tenure in the industry. The model also includes the following covariates: Tenure in industry, prior existence, period effects, depression years, GDP, Ln(Size), size ≤ 50, relative size, industry concentration, scale competition measure, and an interaction of industry concentration and size ≤ 50. See Appendix B for the estimated coefficients associated with these variables.

in the way that they modify firms' propensity to shift positions. For example, the results indicate that nonscale competitors (i.e., firms with annual production of 50 or fewer automobiles) are less likely to change initially, but as the industry concentrates become even more likely than larger firms to explore new market territories. Similarly, firms located in the "low end" of the market turn from less to more likely to change as the combined share of the top four producers increases. Finally, the analysis reveals that the initially positive effect of crowding (the number of firms whose niches overlap with the focal firm) on change in market position reverses direction along with industry consolidation, while at the same time concentration amplifies the positive effect of crowding for nonscale competitors. These effects proved powerful and robust in our analysis.[10]

6. Discussion

Our basic finding is not new—We presented evidence showing that inert organizations are both less likely to change and more likely to fail as a result of transformation. What makes our efforts distinctive here is that we treated inertia as an organizational property that can be triggered, or (partly) contained by the complex interactions between characteristics of the internal context

Figure 2 Change Effects (by Size) on the Failure Hazard of U.S. Automobile Producers, 1885–1981



and the external landscape. In doing so, we benefited from focusing on an organization-based dimension of the environment that revealed shifts in the market structure in terms of the changing configuration of competitors continuously striving to respond to, anticipate, and outpace each other. We also relied on the core-periphery distinction to conceptualize and measure the extensiveness of organizational change in a way that establishes direct links between core structures and process effects of transformation. By taking this approach we were able to investigate processes that unfold at the intersection of organization and environment and shape the occurrence and outcome of organizational change.

One of these processes points to the important interaction between organizational learning and change. We find that experiential learning translates to a survival advantage when implementing a change consistent with past experience is warranted, but makes the organization liable to selection when environmental shifts demand a new repertoire of actions. In our empirical application, the results suggest that in periods when the environment is at rest, firms with prior change experience are more likely (than their counterparts) to remain locked in past behavioral patterns and misinterpret the extent and content of exogenous change. However, whereas position moves synchronized with external shifts increase survival chances, competency traps (i.e., repetitively engaging in outdated actions) elevate failure rates. In sum, whether prior experience is beneficial or not depends on the mechanisms by which firms interpret and respond to their environments.

Organizational inertia develops as a by-product of structural reproducibility, which emerges in response to demands for the reliability and accountability with which an organization can perform certain actions. Reliability and accountability, in turn, are engendered as the organization gains experience and becomes better at the tasks it performs. According to our findings, path-dependent learning induces reproducibility of structure, which then makes the set of organizational actions more reliable, but also more narrow and exclusive. In other words, past experiences simultaneously engender survival advantage in selection processes and liability to inertia that jeopardizes survival. Which of the two properties ultimately decides the outcome of change depends on how the organization-environment dynamic unfolds.

The effects of other important organizational characteristics on change and survival that we considered in this research did not appear to be unidirectional either. Properties of the organizational design influence the likelihood of initiating and surviving transformation by mechanisms that also reflect interaction effects with the environment. Generalism, or broad technological niche, for example, is by and large associated with exploratory learning. Organizations that operate across multiple domains (i.e., support multiple products) by definition must be able to tolerate variation of outcomes and to devote slack resources to support it. When shifts in the external context reshuffle the distribution of resources, generalists are more likely than specialists to already possess experience and competencies in the market areas in which resource availability expands. Additionally, operation across multiple market domains fosters the development of routines and practices that facilitate the transferring of internal resources between different domains, and such routines and practices may be drawn upon when an organization embarks on a transition between different states.

So, we find that firms with broad technological niches are better able to weather the negative process effects of transformation, independent of the state effects associated with being a generalist posited by the theory of evolution of organizational niches. This finding is important because it underlines the value of using an established theory of the organization-environment relation in conjunction with the study of organizational change. Combining the two, we show that the niche width effect reverses from beneficial to detrimental along with rising market concentration. When organizations adjust their operational domains to reflect these changes in the characteristics of environmental states, generalists have a higher probability of doing so successfully.

However, while generalist organizations are more likely to survive position change, they are also less likely to initiate it, according to our findings. This supports our conjecture that as organizational niches expand, innovation likely becomes routinized within the context of the evolving organizational structure (Dobrev and Barnett 2002). Overall, we think our findings and theorizing point to a useful symbiosis between ecological and learning theory which future research can elaborate in analyses of organizational change.

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Appendix A Estimated Effects of Other Covariates in Models in Table 2

Model Number	2a	2b
Industry Tenure and Prior Experience		
Tenure in the Industry		
$u < 1$	−0.66 (−2.85)	−0.65 (−2.76)
$1 \leq u < 3$	−0.56 (−2.41)	−0.59 (−2.50)
$3 \leq u < 7$	−0.80 (−3.41)	−0.90 (−3.72)
$7 \leq u < 15$	−0.91 (−3.81)	−1.05 (−4.21)
$u \geq 15$	−1.14 (−4.41)	−1.35 (−5.04)
Prior Existence	−0.02 (−0.75)	−0.03 (−0.93)
Socio-Econ-Industrial Environment		
Mass Production	−0.05 (−0.78)	−0.05 (−0.73)
Production Differentiation	−0.28 (−1.96)	−0.12 (−0.79)
JIT/TQC	−0.53 (−3.30)	−0.34 (−2.07)
Depression Year	0.06 (1.36)	0.08 (1.79)
GDP	0.001 (2.66)	0.001 (1.30)
Organizational Size-Based Measures		
Ln(Size)	−0.01 (−0.98)	0.01 (0.57)
Size $\leq$ 50	−0.70 (−3.78)	−0.62 (−3.22)
Relative Size ($\times 10^{-3}$)	−0.01 (−2.21)	−0.01 (−0.06)
Industry Concentration (C4)	0.74 (2.71)	0.74 (2.64)
Evolutionary Processes:		
Scale Competition $\times$ Size > 50	−0.001 (−0.15)	0.001 (0.22)
C4 $\times$ Size $\leq$ 50	0.71 (3.46)	0.72 (3.33)

Note. Other estimated effects in models appear in Table 2.

Appendix B Estimated Effects of Other Covariates in Models in Table 3

Model Number	3a	3b
Industry Tenure and Prior Experience		
Tenure in the Industry		
$u < 0.5$	−1.72 (−2.76)	−1.62 (−2.60)
$0.5 \leq u < 1$	−1.75 (−2.81)	−1.60 (−2.58)
$1 \leq u < 3$	−2.18 (−3.48)	−2.03 (−3.25)
$3 \leq u < 7$	−2.29 (−3.66)	−2.17 (−3.74)
$u \geq 7$	−1.78 (−2.44)	−1.61 (−2.21)
Prior Existence	−0.11 (−2.31)	−0.10 (−2.22)
Socio-Econ-Industrial Environment		
Mass Production	0.79 (4.48)	0.76 (4.30)
Production Differentiation	0.45 (1.74)	0.54 (2.13)
JIT/TQC	0.49 (1.32)	0.43 (1.16)
Depression Year	−0.22 (−3.17)	−0.22 (−3.12)
GDP	−0.003 (−2.81)	−0.003 (−2.71)
N	−0.01 (−2.63)	−0.02 (−2.82)

Appendix B (cont'd.)

Model Number	3a	3b
N^2 ($\times 10^{-4}$)	0.55 (2.27)	0.59 (2.45)
$N \times$ Ind. Age ($\times 10^{-3}$)	0.56 (1.88)	0.65 (2.19)
$N^2 \times$ Ind. Age ($\times 10^{-5}$)	−0.39 (−2.41)	−0.43 (−2.61)
$N \times$ Ind. Age^2 ($\times 10^{-4}$)	−0.10 (−2.13)	−0.11 (−2.41)
$N^2 \times$ Ind. Age^2 ($\times 10^{-6}$)	0.08 (2.58)	0.09 (2.74)
Density at Entry	0.001 (2.61)	0.001 (2.02)
Organizational Size-Based Measures		
Ln(Size)		
$u < 7$	−0.12 (−4.22)	−0.19 (−5.95)
$u \geq 7$	−0.14 (−2.41)	−0.23 (−3.77)
Size $\leq$ 50		
$u < 7$	1.51 (3.05)	1.42 (2.87)
$u \geq 7$	0.93 (1.57)	0.82 (1.39)
Relative Size ($\times 10^{-3}$)	−0.02 (−2.26)	−0.02 (−1.57)
Industry Concentration (C4)	1.33 (1.80)	1.35 (1.86)
Evolutionary Processes:		
Scale Competition $\times$ Size > 50	0.03 (3.33)	0.03 (2.77)
C4 $\times$ Size $\leq$ 50	−1.08 (−1.77)	−1.07 (−1.77)

Note. Other estimated effects in models appear in Table 3.

Appendix C GEE Estimates of a Two-Stage Pooled Logit Regression Model of the Disbanding/ Exit of U.S. Automobile Manufacturers, 1885–1981

Industry Tenure and Prior Experience	
Tenure in the Industry	0.01 (0.44)
Prior Existence	−0.17 (−2.94)
Socio-Econ-Industrial Environment	
Mass Production	1.07 (4.78)
Production Differentiation	0.76 (2.14)
JIT/TQC	0.63 (1.31)
Depression Year	−0.31 (−3.69)
GDP	−0.01 (−2.80)
N	−0.02 (−2.49)
N^2 ($\times 10^{-4}$)	0.64 (2.12)
$N \times$ Ind. Age ($\times 10^{-3}$)	0.65 (1.81)
$N^2 \times$ Ind. Age ($\times 10^{-5}$)	−0.48 (−2.34)
$N \times$ Ind. Age^2 ($\times 10^{-4}$)	−0.12 (−2.05)
$N^2 \times$ Ind. Age^2 ($\times 10^{-6}$)	0.10 (2.53)
Density at Entry	0.001 (2.11)
Organizational Size-Based Measures	
Ln(Size)	−0.25 (−7.38)
Size $\leq$ 50	1.20 (2.49)
Relative Size ($\times 10^{-3}$)	−0.02 (−1.30)
Industry Concentration (C4)	1.45 (1.87)
Evolutionary Processes:	
Scale Competition $\times$ Size > 50	0.03 (2.70)
C4 $\times$ Size $\leq$ 50	−0.97 (−1.63)

Appendix C (cont'd.)

Technological Niche Width and Position	
Niche Width (NW)	−0.06 (−5.13)
Position:	
Distance Above Market Center (DAMC)	0.02 (1.63)
Distance Below Market Center (DBMC)	0.06 (4.48)
Change in Relative Position	0.002 (0.55)
Evolutionary Processes:	
C4 $\times$ NW	0.08 (5.41)
C4 $\times$ Position: DAMC	−0.02 (−1.29)
C4 $\times$ Position: DBMC	−0.06 (−4.18)
C4 $\times$ NW $\times$ Size $\leq$ 50	−0.01 (−1.43)
Overlap Density	
Niche Overlap (NO)	0.01 (2.86)
Evolutionary Processes:	
C4 $\times$ NO	−0.01 (−2.27)
C4 $\times$ NO $\times$ Size $\leq$ 50	0.01 (2.87)
Absolute Position Change	
Niche-Center Change (NCC)	−0.32 (−2.99)
Cumulative Niche-Center Change (CNCC)	−0.04 (−1.25)
Time Since Last Change	0.07 (1.31)
Market-Center Stability	−0.10 (−0.78)
Evolutionary Processes:	
NCC $\times$ Ln(Size)	0.26 (3.69)
NCC $\times$ Ln(Size)^2 ($\times 10^{-1}$)	−0.16 (−1.82)
NCC $\times$ NW	−0.01 (−3.14)
Selectivity	−0.25 (−0.78)
Constant	−1.65 (−2.49)
Number of Observations	8,892
Number of Firms	2,051
Wald X^2	830.92

Note. T-statistics are in parentheses. Scale parameter = 1; Selectivity term includes second-order effects of covariates from Model 2b.

Endnotes

[1]Theories whose arguments typically rest on assumptions about organizational adaptation include resource dependence (Zald 1970, Pfeffer and Salancik 1978), contingency theory (Lawrence and Lorsch 1967; Galbraith 1973, 1977), transaction cost economics (Williamson 1975, 1981), and institutional theory (Meyer and Rowan 1977, Meyer and Scott 1983), among others. At least implicitly, these theories treat organizations as capable of profound transformation—be it in response to the reshuffling of resources in the environment to safeguard transactions, or in response to the normative diffusion of structural models. By contrast, the theory of structural inertia (Hannan and Freeman 1984, Barnett and Carroll 1995) posits that fundamental change degrades structural reproducibility, and thus diminishes the organization's capacity to act as a reliable and accountable corporate actor.

[2]However, several studies report no evidence that the hazard of failure subsides as a function of time elapsed after the change. Thus, change-induced failure may be a function of both inertia (process) and maladaptive transformation to the wrong state (Minkoff 1999, Dobrev et al. 2001).

[3]The niche concept has proved central in understanding the organization-environment relation, a dynamic that we seek to integrate more closely here to the analysis of organizational change. Relying on the definition of niche as a multidimensional constrained resource space including social, economic, and political dimensions (Freeman and Hannan 1983), subsequent analyses have shown how organizational environments affect the viability of particular types of organizations (Carroll 1988, Singh 1990, Baum and Singh 1994b) and how the locations of organizations relative to each other along one (or a few) dimension(s) of resource space affect the dynamic of competition (Baum and Mezias 1992, Baum and Haveman 1997). In all, while the primary advantage of conceptualizing the content-process model of change in terms of technological niches is the explanatory power of the niche concept, a secondary but equally important benefit is that doing so allows us to seed our theory with broader ideas from organizational sociology and integrate them within the framework of our model.

[4]Another way to state this hypothesis might be "The relative momentum of change will increase with market stability." However, this wording gives some a mistaken impression about the expected effect of market stability. We thank a reviewer for suggesting the alternative wording.

[5]In Dobrev and Carroll's (2003) assessment, automobile manufacturing firms had to reach certain minimally sufficient size levels to experience competitive pressures from scale differences. Therefore, they limited their statistical analyses of scale competition to only the "larger" firms in each of several populations, based on annual production output to indicate scale. The use of a size threshold to classify firms as scale competitors is admittedly imperfect, but it is justified strongly by the history and cost structure of the automobile industry. It is also supported by some limited data we have on American automobile producers, showing that the smallest firms were most likely to engage in custom production, to operate out of a garage or shop rather than a factory, to use nongasoline engines, and to offer specialist designs such as cycle cars, highwheelers, triwheel cars, kits cars, replica cars, and the like. In our view, this is a conservative cutoff point because it uses many small firms that are perhaps not subject to strong scale pressure.

[6]Niche overlap can be measured in a variety of different ways, most notably by weighing the fraction of a firm's niche that overlaps with others as opposed to just counting the number of overlaps (Baum and Singh 1994a). However, constructing the fractional measure requires precise knowledge of the distribution of production within each firm's niche, which is unavailable to us.

[7]Although we do not know the exact number of models produced within the niche of each firm, historical evidence, industry accounts, and empirical data (where available) convinced us that the assumption of a symmetric distribution of technological *capabilities* for automobile production across the firm's scope is justified. With this assumption, the midpoint of the niche is a valid representation of a firm's position in technological space.

[8]We also tested an alternative explanation to Hypotheses 2 and 3: Large generalists' propensity to repeat prior changes declines as a function of some unobserved state effect. That is, the arrival at a market state (rather than subsequently developing organizational design features) that allows firms to experience sustained growth and expansion is what triggers the decline in the intent to change. We tested this alternative explanation by considering whether scale-driven positional advantages enjoyed by an organization in its current state explains away the hypothesized effects of niche width and size. We used relative size as a proxy for state-related advantage and interacted it with cumulative prior change. The effect was insignificant and did not improve fit, so we concluded that our support for Hypotheses 2 and 3 is not an artifact of prior successful organizational performance.

[9]An implicit fallacy in estimating effects of change on mortality has to do with the likelihood that organizations in trouble, that are already at risk of failure, might also be more prone to resort to change (Carroll and Hannan 2000). In this way, the deleterious effect of change on survival might be due not to processes related to internal transformation (as we theorize here), but to the already elevated failure chances of firms that embark on it. To eliminate the potentially spurious effect of change on survival, we re-estimated the failure-rate Model 3b using a two-stage specification (Heckman 1979, Lee 1983) in which the estimates from the rate-of-change Model 2b were included as a control. The results, estimated using the method of generalized estimating equations (the XTGEE module in version 6.0 of STATA) and presented in Appendix C, are remarkably similar to the ones obtained using the event history specification.

[10]In the face of conflicting findings from the analysis of niche-width expansion in the Italian auto industry (Kim et al. 2003), we are not sure how to interpret these coefficients without resorting to ad hoc explanations. More research is needed to untangle the implications of scale and scope for change in market position.

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